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REPORT ON SITES FOR POTENTIAL PULP MILLS IN THE SNAKE AND GREEN RIVER BASINS IN RELATION TO WATER SUPPLY AND DISPOSAL OF WASTES

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PREPARED FOR
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REPORT ON SITES FOR POTENTIAL PULP MILLS IN THE SNAKE AND GREEN RIVER BASINS IN RELATION TO WATER SUPPLY AND DISPOSAL OF WASTES

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Public Health Service
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With Assistance and Review by

Idaho Department of Public Health
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Wyoming State Department of Public Health
Oregon State Board of Health
The Forest Service
U. S. Department of Agriculture

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16. Abstracts A feasibility study is presented on the suitability of several site locations for potential pulp mill development from the standpoint of water supply and waste disposal. Water is a much sought-after commodity in the area and is subject to comprehensive control with respect to development and use of available supply; however, conclusions reached in this report do not constitute a commitment that indicated flows will be available. Factors influencing selection of possible mill sites for study include location of timber, transportation facilities, suitable land for plant location, water supply, waste disposal, labor supply, and other economic factors.

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Forest Service personnel contributed much to the report through background data and information and assistance in collecting additional data needed.

State Health Department personnel of Idaho, Oregon, Utah, and Wyoming assisted in furnishing advice of existing waste loads, water quality objectives, and other matters. They were also of much help in reviewing drafts of the report and offering suggestions for improvement. State engineers concerned with water resources development and control also furnished valuable information on the water supply situation in the area.

The Region I Office of the Bureau of Reclamation furnished consultation on the water development situation in the area and also furnished estimates of future flow conditions as indicated elsewhere in the report.

The District Engineer, U. S. Geological Survey, Idaho Falls, furnished considerable advice on the complex water use situation in the upper Snake River area. Published data of the U. S. Geological Survey was the source of basic information on flows of record.

SUMMARY AND CONCLUSIONS

1. The purpose of this report is to assist the Intermountain Forest and Range Experiment Station, U. S. Forest Service, Ogden, Utah, in an evaluation of the potentialities of pulp mill development in certain areas of Idaho and Wyoming. The scope of the report is limited to consideration of the water supply and waste disposal aspects of the study.

2. The areas considered for potential pulp mill sites were designated by the Forest Service on the basis of general factors. These included location of timber, transportation facilities, suitable land for plant location, water supply, waste disposal, and other factors. The general site areas considered included: (a) along the Snake, Boise, and Payette Rivers in the Boise-Payette-Weiser area in Western Idaho; (b) along the Snake River in the Bliss-Hammett area in South-Central Idaho; (c) along the Snake River and Henry's Fork in the Blackfoot-St. Anthony-Heise area in Eastern Idaho; (d) along Ham's Fork in the vicinity of Kemmerrer in Southwestern Wyoming; and (e) along the Green River in the Green River area in Southwestern Wyoming.

3. The study and report present a considered opinion of the feasibility of pulp mill installation in the areas based on existing data and information made available from several sources. Should definite proposals be made for installation at any specific site more detailed studies should be made for that site and the type of installation proposed and agreement reached with the State Health Departments regarding water pollution control features.

4. Water is a limited commodity in the area and is vital to the economic development. Management and control of its use and development and control of polluting wastes are responsibilities of various State agencies in the States affected. Definite proposals for industrial development involving use of water for process purposes and to receive waste effluents is a matter for the official attention of those agencies.

5. There are several processes in use for the production of wood pulp. Primary consideration has been given to the sulphate, or kraft, process because of its applicability to the available timber species and because, as compared to the calcium bisulphite process, the waste load is of much less magnitude. The sulfite processes (calcium, magnesium, and ammonium) have not been considered because of doubtful applicability to one of the principal timber species. Also, the large waste loads from the calcium base sulfite process is a factor. Mechanical, or groundwood pulp, has been considered.

6. Inclusion of plants to process raw pulp into end-products may add materially to water use and waste loads. Such plants have been considered.

7. Improved design and operation of pulp mills has made possible material reduction in waste loads experienced in the past. The study assumes these improvements will be applied rigidly. The bases for the analysis are stated in the report. Should it be contemplated, for any reason, that there will be departure from the assumed basis for any installation, a re-evaluation of limitations on capacity should be made. Other special control measures are also possible and are indicated where required to make feasible installation of a pulp mill or increase in capacity.

8. The water supply and waste disposal aspects are favorable for installation of a 500 ton to 1,000 ton kraft pulp mill or pulp and paper mill producing a bleached product on the Snake River below Weiser. Conditions are favorable for a similar installation on the Snake River in the Bliss-Hammett area.

9. Suitability of a site along the Snake River in the Roberts area for a pulp mill installation is contingent on control of existing waste loads. (Reference detailed discussion of the peculiar circumstances.) With reasonable control of existing waste loads the oxygen demand of pulp mill wastes would not be a problem. If such control is provided a 250 ton pulp and paper mill or, with special measures to control toxicity, a 500 ton pulp and paper mill, could be installed. In view of existing waste loads, long term storage of wastes before discharge would be strongly recommended. This provision should be a definite requirement for the larger size indicated if bleaching is included.

10. Installation of a mill on Ham's Fork near Kemmerer, Wyoming, is not considered feasible.

11. A 150 ton kraft pulp and paper mill could be installed below Green River, Wyoming, on the Green River provided long term storage is used, so that wastes could be released during most favorable flow conditions. Long term storage would also reduce magnitude of the oxygen demand of the wastes and would permit inclusion of paper making, if desired. With special measures to control the toxicity factor and sufficient length of storage a 200 ton mill appears feasible. Analysis of this area is based on stream flows under present conditions of water resource uses. Possibility of

development of consumptive water uses upstream may make installation of a pulp mill inadvisable. This should be investigated in cooperation with appropriate State agencies, in advance of definite proposals for mill installation.

12. In all cases, lagoons are recommended to level out unexpected peak loads. Lagoons should also be of sufficient capacity to compensate for short-cycle fluctuating stream flows due to power operations. As indicated elsewhere, longer term storage should be provided for the Green River and Roberts areas. Also the lagoons will serve the necessary purpose of removing residual fiber losses remaining after in-plant treatment for fiber recovery.

13. Groundwood pulp mills appear feasible at the Weiser, Bliss, Hammett, Roberts, and Green River sites, without any particular limit on size within a range believed to be contemplated. Addition of bleaching process or end-product plants at such mills would require consideration of the processes contemplated. Adequate measures should be provided to control fiber losses to the stream.

14. A primary factor in selection of pulp mill locations, not considered specifically in this report but which should be recognized, concerns atmospheric odor nuisances. An investigation of meteorological conditions and other factors should be made and consideration given to needed in-plant odor control measures before final selection of a pulp mill site. This is also a matter in which agreement should be reached with appropriate State authorities.

INTRODUCTION

The U. S. Forest Service is studying potentialities of industry development to utilize timber production of the forests in southeastern Idaho, western Wyoming and northern Utah. Pulp mills are included in the industries being considered. In determining feasibility of development of such industries the Forest Service requested the Public Health Service to assist in those features of the study which related to water supply and waste disposal.

Pursuant to the request of the Forest Service this report presents an appraisal of the suitability of several site locations for potential pulp mill development from the standpoint of water supply and waste disposal. It is emphasized that this is a preliminary study for the purpose of giving a considered opinion of feasibility of the industrial development. Should the Forest Service study eventually result in definite proposals for industrial development at specific locations it is necessary that more detailed studies be made in several respects. It is recognized that water is a much sought-after commodity in the area and is subject to comprehensive control with respect to development and use of the available supply. While this report is based on the best information available from responsible sources it is obviously understood that conclusions reached do not constitute a commitment that indicated flows will be available. Such commitments could be made only by those exercising control over water use when definite industry needs become known. Conclusions on existing waste loads discharged to the stream are based on information and data which were readily available.

They are considered adequate for a preliminary study. In the event a specific site (or sites) is selected for industrial development a more detailed study of existing conditions, forecasted waste loads from other sources, waste loads from the type of pulp mill proposed, effects of wastes on State and interstate streams, and related matters should be made. In this connection it is pointed out that responsibility for water pollution control rests with the States concerned. Accordingly, final decisions in this respect are matters for the appropriate State agency.

There are several factors which influenced selection of possible mill sites for study. These include location of timber, transportation facilities, suitable land for plant location, water supply, waste disposal, labor supply, and other economic factors. The general locations to be considered were designated by the Forest Service on the basis of the several factors involved.

The potential sites studied are situated in the States of Idaho and Wyoming. However the streams which would receive wastes, either directly or through tributaries, flow into or border on the States of Utah and Oregon. Consequently, satisfactory disposal of wastes is of interest to the State Health Departments of all four States.

In the request for assistance the Forest Service expressed the desire that the Public Health Service consult with appropriate State personnel, particularly with respect to waste disposal. Consultations were held with State Health Department personnel prior to preparation of the report. Preliminary drafts of the report have been furnished them for review and

comment. Comments received have been taken into consideration in preparing the final draft.

INVESTIGATIONS AND PRESENTATION OF DATA

Scope of Investigations and Sources of Data

Five general areas in which site investigations were to be made were designated by the Forest Service on the basis previously discussed. These were as follows: (1) Along the Snake, Boise, and Payette Rivers in the Boise-Payette-Weiser Area in Western Idaho; (2) Along the Snake River in the Bliss-Hammett Area in South-Central Idaho; (3) Along the Snake River and Henry's Fork in the Blackfoot-St. Anthony-Heise Area in Eastern Idaho; (4) Along Ham's Fork in the vicinity of Kemmerer in South-Western Wyoming; and (5) Along the Green River in the vicinity of Green River in South-Western Wyoming.

During August and September 1955, field investigations of the selected sites were made and consultations held with personnel of State and Federal offices having data and information on factors pertinent to the study.

Inspections of the Idaho sites were made in company with Forest Service and Idaho State Health Department personnel. Inspection of the Green River site in Wyoming was made in company with Forest Service and Wyoming State Health Department personnel. No field investigation of the Ham's Fork Area was made since prior study of low flow records indicated that this area was unsuitable.

Information to the extent available was obtained from State Health Departments concerning pollution loads. Results of stream sanitation survey of the Snake River were obtained from the Idaho Health Department. Objectives with respect to water quality in the streams were also discussed with the Health Departments.

The Bureau of Reclamation office at Boise was visited. General information on use and control of water in the Idaho area was obtained. Discussions were held concerning forecasted effects of existing and proposed water resources developments on past flows of record. Subsequently the Bureau office furnished estimates of these effects.

State agencies in Idaho, Wyoming, and Utah, having responsibilities concerned with control of the development and use of water resources were visited. Information and views on the existing and future water situation were obtained. Special attention was given to the water supply and use situation in the Blackfoot-St. Anthony-Heise Area through consultation with the District Engineer, U. S. Geological Survey, in that area.

Basic data on past flows were obtained from U. S. Geological Survey records. These were used, in conjunction with data and information referred to previously in appraising probable future flow conditions.

General Site Information

Boise-Payette-Weiser Area

The general area considered included the area along the Payette River from Horseshoe Bend to the mouth of the river; along the Snake River from the mouth of the Boise River to just below Weiser; and the Boise River from Boise to the mouth of the river.

Above Horseshoe Bend the Payette River is in "canyon" topography. It did not appear desirable to consider areas above this point for major industrial sites. From Horseshoe Bend downstream there are areas which, from the topography standpoint, could be used for industrial plant location. In the vicinity of Montour irrigation farming starts. From there to the mouth of the river irrigable lands are largely under irrigation. There is diversion above Horseshoe Bend to irrigate 50,000 acres. Water is diverted above Emmett to irrigate about 135,000 acres. There are proposals to divert water from above Horseshoe Bend to the Boise River basin and from there south to the Mountain Home Area.

Below the City of Boise virtually the entire flow of the Boise River is utilized during the irrigation season. There seems little reason for considering potential pulp mill sites along the lower Boise River due to low flow conditions, present waste loads, and proximity of the Snake River.

There are areas along the Snake River from the mouth of the Boise River to below Weiser which, physically, would be suitable for pulp plant locations. The City of Weiser is the only location in the area taking water from the Snake River for a public water supply. Shortly below Weiser the river enters Hell's Canyon. Little municipal or industrial use developments are to be expected for many miles between this point and Lewistown except for hydroelectric power development.

Bliss-Hammett Area

There are land areas which could be used for pulp mill sites. There is very little municipal or industrial development for many miles downstream.

From just below Bliss upstream there is considerable irrigation development. There are at present only minor irrigation areas downstream. Consideration has been given to construction of a high dam on the Snake River downstream from Hammett for irrigation purposes. It is understood that, at this time, the project is not considered to be a favorable one. If a pulp mill is considered for this area, attention should be given to possible daily fluctuation in river flow due to power operations and possible arrangements for controlled release of wastes by use of storage lagoons. In this connection reference is made to later comments on desirability of providing lagoons in any case.

Blackfoot-St. Anthony-Boise Area

Patterns of storage, reservoir releases, irrigation diversions, and recharge to the streams are quite complicated in this area. Prior water rights and issuance of future rights (including taking of previous rights) are governing influences in considering possible industrial sites. Between Heise and Henry's Fork on the Snake River there are several irrigation diversions. At times the Snake River is essentially dry at Lorenzo (above confluence with Henry's Fork). Recharge by return irrigation and flow water from Henry's Fork result in substantial minimum flows downstream from Roberts. Irrigation withdrawals downstream again reduce the flow. It is understood that minimum flows at Shelley (downstream from Roberts) can be expected to be 300 to 400 cfs lower than at Roberts. Further discussion of flows and consideration of possible effects on future flow by future developments are presented in a later section of the report. In considering possibilities of the area the question arose as to availability of

water for consumptive use. Discussion with State personnel indicates the possibility that water can be obtained. One solution would be to replace water used by pumping to the river at a location farther downstream where the water table is below the river level and, hence, is not a factor in natural recharge. All of these observations lead to the thought that the most likely place for pulp mill sites would be in the Menan-Roberts area along the lower part of Henry's Fork or along the Snake River. Suitable land areas, including undeveloped low-cost land, appear available.

Green River Area

Possible sites in the area were considered limited because of limited transportation facilities. The only railroad runs east and west through the City of Green River. Surface water supply of any consequence is limited to the Green River, flowing south. Since the city obtains its water supply upstream it was concluded that site possibilities were limited to an area downstream from the city. There is a large area of undeveloped land downstream which has suitable topography for an industrial plant location.

In all site investigations availability of space for holding lagoons for wastes was considered. This was considered particularly important in areas having the lower stream flows (Blackfoot-St. Anthony-Heise area and Green River area). There appears to be available within all the general site areas, low cost (undeveloped) land which would be suitable for large lagoons.

WATER SUPPLY

The existing water resources developments, water uses, and control of water rights in the entire area considered are influencing, and largely controlling, factors in determining feasibility of an industrial development requiring large quantities of water for process and waste disposal purposes. Probable future developments will accentuate this influence. With this in mind information was obtained on existing and probable future conditions.

Past flow data were obtained from U. S. Geological Survey records for selected stations available in the area being studied. Minimum daily flows were tabulated for each quarter of the year for the period of years considered or for which records were available. The Bureau of Reclamation Office Boise, Idaho, furnished information on probable minimum mean monthly flows in the future, on a quarterly basis, for the Idaho area. The Bureau advised that the predicted flows were based on recurrence of 1928-1952 hydrologic conditions and irrigation development at a level reasonably expected in the foreseeable future with recent economic trends. The information is not necessarily representative of ultimate development conditions. It was also pointed out that absolute minimum flows would be less than the minimum monthly means. More detailed and comprehensive consideration of probable future flows would have required large expenditures of time and money which were not available. The Bureau estimates that, considering the methods of analysis employed, the derived values are within plus or minus 25 per cent. The flow data referred to are contained in Tables 1 and 2.

Previous reference has been made to a proposal for diversion of water from the Payette River for irrigation use outside the basin. The tabulation in Table 2 of estimated future minimum month flows shows flows of 50 cfs for the Payette River at Horseshoe Bend and 20 cfs at Emmett.

The historical flow record tabulated in Table 1 is representative of anticipated future conditions in the Boise River below Boise, Idaho.

Minimum mean monthly flows estimated for the Snake River at Weiser, Murphy, King Hill and Hagerman are quite substantial. Particular attention is called to explanatory notes under Table 1 which comment on variation from average monthly flows due to power operations and other factors at these locations.

For Henry's Fork at Rexburg the estimated average discharge for the minimum month is 50 cfs. The explanatory notes indicate that future conditions are not expected to be materially different from present conditions. Records of previous data from 1940 to 1952 inclusive show a minimum daily flow of 595 cfs. From these observations it is concluded that a future minimum mean monthly flow of 50 cfs would be of rare occurrence. A minimum flow of 600 cfs or greater could be expected in most years.

Predicted minimum mean monthly flows for the Snake River at Heise and Shelley are 1,800 (Oct. - Dec.) and 1,175 (Apr. - June) cfs respectively. Minimum flows for Heise during the July - Sept. period are estimated at 4,450 cfs and for Shelley 2,100 cfs. Shelley is located below Heise and Henry's Fork joins the Snake River in between. Large irrigation diversions are made just below Heise during the irrigation season. During the field visit local officials advised that flows in the Snake River in the Lorenzo

area had been reduced to practically nothing. They also advised that minimum flows in the Snake River at Roberts (downstream from Henry's Fork) were higher than at Shelley by some 400 cfs during the irrigation season. Although flow conditions above diversions in the Heise area are at least equivalent to those in the Roberts area, accessibility to rail facilities above Heise is not as good. In summary it is concluded that the most suitable location for pulp mill development in this general area, taking into consideration water and transportation, is in the Roberts area.

Past flows of record for Green River at Linwood, Utah, and Fontenelle, Wyoming are tabulated in Table 1. There is considerably more drainage area tributary to the Green River at Linwood than at Fontenelle. The City of Green River is located between the two gaging stations. The tabulated data show that, for the period when records are available at both stations, the low flow for three years of lowest flow are very nearly the same at both stations. This would indicate that low flows at Linwood are representative of low flows at Green River. A report entitled "Report on Development and Utilization of Wyoming's Colorado River Basin Water Resources," prepared for the Wyoming Natural Resources Board, January 1955, contains tabulations of flow data. Selected data based on these tabulations, showing comparison of flows at Green River and Linwood are presented in Table 3.

Data from the same source shows an average annual flow at Green River for the minimum year (1915-1939 period) of 530 cfs. The 1931-1940 mean flow was 1,270 cfs (918,400 acre feet per year).

Critical flows of record are not necessarily representative of critical flows which may be expected in the future. The Water Utilization Report referred to previously contains information on existing and potential irrigation uses and water available for such uses under limitations of the Colorado River Compact. Instantaneous or short period critical flows to be expected at Green River in the future will depend on a number of factors, including: extent of development of consumptive water uses; direct diversions from natural flow; provision of storage; releases from storage during critical flow periods; and other factors. Prediction of effects of these factors is beyond the scope of this report. Conclusions are based on critical conditions of record. Any needed modification in these conclusions, anticipated because of modification in water use and control, is a matter for consideration by those responsible for water resources control.

TEMPERATURE AND STREAM CHARACTERISTICS

Water temperature is a factor in ability of streams to satisfactorily dispose of wastes discharged to them. Based on stream survey data obtained in 1950 and 1951, furnished by the Idaho State Health Department, summer temperature of the Snake River and tributaries frequently reach 70 to 75 degrees Fahrenheit. Winter temperatures are assumed at 32 degrees.

The rate of the self-purification process in a stream and the magnitude of effects on water quality is influenced by stream characteristics such as velocity, turbulence, and depth and on the characteristics of the wastes discharged to the stream. The stream factors can be determined by appropriate survey methods for any particular location. For this preliminary

study approximations are made based on observations of the stream characteristics. The lower Henry's Fork, the Snake River in the vicinity of Henry's Fork, and the Green River are rather shallow, have fairly fast velocity (3 to 5 feet per second under low flow conditions) and, with some exceptions, have beds which do not promote a great amount of turbulence. The Snake River in the Weiser area is moderately deep, has a low flow velocity estimated at 1 to 2 feet per second, and is nonturbulent. Characteristics of the Snake River in the Bliss-Hammett area depend on the area being considered. It is considered that factors for this area are approximately between those in the upper Snake and those in the Weiser area.

Ice cover will have a marked effect on the self-purification factor because of reduced reaeration. This is doubly important where there are upstream sources of pollution since normal recovery of oxygen depletion caused by the upstream wastes may not have taken place during the flow time to the potential pulp mill site. This, in addition to reduced, or perhaps almost non-existent, reaeration downstream there would be a reduced initial oxygen supply. Information was furnished on past ice conditions by State and Federal personnel in the area. This information indicates that freezing of the Snake River from Twin Falls to below Weiser (limits of lower areas under consideration) has not been observed. There have been winters when the Snake River is entirely frozen over between Heise and Blackfoot. There seems to be less ice recently than in earlier years. Ordinarily the river remains open in the center for 25 to 50 per cent of the width. The three Idaho Falls power pools, above Idaho Falls often freeze over entirely. Due to groundwater inflow near the mouth of Blackfoot River (at Blackfoot,

Idaho) the river does not freeze over from Blackfoot to American Falls Reservoir, a distance of about 20 miles. The American Falls Reservoir is usually ice covered for a considerable period each winter. Specific information has not been obtained on ice cover on the Green River in Wyoming. Undoubtedly, however, there will be prolonged periods when the river is completely covered with ice.

Water Uses Pertinent to Consideration of Specific Pulp Mill Sites

Pertinent uses having a bearing on sites considered are as follows:

Boise-Payette-Weiser Area

Municipal water supply is taken from the Snake River at Weiser. Recommendations will be that a pulp mill in this area should be located below Weiser. Maintenance of the river in suitable condition for fish and aquatic life will be a criterion. Possible irrigation uses should be protected.

Bliss-Hammett Area

No domestic water supplies affected. There are some and possibly may be more irrigation uses. Fish and aquatic life should be protected.

Blackfoot-St. Anthony-Heise Area

The first public water supply taken from the Snake River below possible mill sites above Idaho Falls is for Twin Falls. The diversion for this purpose is at Milner dam. This supply would not be affected by pulp mill location at the upstream location. Protection of irrigation uses, fish and other aquatic life, would be required.

Green River Area

The City of Green River obtains water supply from the river above the city. This limits possible pulp mill location to an area below the city. Protection of fish and other aquatic life would be required. There are no known uses downstream in Wyoming or Utah which would be adversely affected.

Existing Waste Loads Pertinent to Consideration of Pulp Mill Sites

Principal organic wastes contributed to the Snake River or to tributaries a short distance from the Snake River in the Boise-Payette-Weiser Area are as follows:

Mile Point(1)	Waste Discharge to Stream (Pop. Equiv. - B.O.D. Basis)
IDAHO	
S 411	800
S 413	1,000
S 391 Boise River enters Snake River	
S 391 - B 54	3,500
S 391 - B 22-10	286,700
S 391 - B 21	11,900
S 391 - B 20-1	10,500
S 391 - B 10-9	81,900
S 391 - B 7-7-2-2	54,000
Miscellaneous sources from	
S 391 - B 28 to B 52 (Incl. Tributaries)	10,000

Mile Point(1)	Waste Discharge to Stream (Pop. Equiv. - B.O.D. Basis)
IDAHO (Continued)	
Miscellaneous sources from	
S 391 - B 7 to B 26 (Incl. Tributaries)	39,000
S 373	8,500
S 368 - P 30	11,200
S 368 - P 1	4,500
S 368 - P 2	1,800
S 351 Weiser, Weiser River enters	
S 351	4,000
OREGON	
S 393 Owyhee River enters	
S 389	313,000
S 369	5,000

(1) Explanation of Mile Point Code: "S" refers to Snake River, "B" to Boise River, and "P" to Payette River. The number immediately following the letter designates miles above the mouth of river. Numbers indicated thus - 10 and not preceded by a letter designates miles above mouth of an unnamed tributary discharging to the next preceding stream.

Principal waste loads in and above the Bliss-Hammett Area are indicated in the following tabulations:

Mile Point(1)	Waste Discharged to Stream (Pop. Equiv. - B.O.D. Basis)
S 651	12,000
S 648 - 8	305,800

Mile Point(1)		Waste Discharged to Stream (Pop. Equiv. - B.O.D. Basis)
S 615 - RC 10		326,000
S 615 - RC 6		13,000
S 615 - RC 6		68,700
S 610		100,000*
S 595		28,000
S 570	Hagerman	
S 560 (Approx.)	Bliss	
S 524 (Approx.)	Hammett	

(1) S = Snake River
SC = Rock Creek

* Major part of this waste discharged to a subsurface lava crevice.

Principal waste loads having a possible bearing on selection of a pulp mill site on the Snake River above Idaho Falls are as follows:

S 838 - HF 30		77,000
S 837 - HF 11 - 8		5,200
S 815	Roberts	Minor Waste
S 799 - 800		328,000
S 760		98,000
S 791		4,300
S 734 - 10		32,000

Data in the tabulation of waste loads were obtained from the Inventory of Municipal and Industrial Waste Facilities, 1953, supplemented by more recent information furnished by the State Health Departments.

Water Quality Data

Water quality to be used for process and power plant purposes is an important consideration. Limited available data on water quality are presented. These data are not representative of all conditions which may be expected but will serve to indicate some of the water quality characteristics.

Snake River Water Quality Data

Location	Date 1950	Hardness	Total Solids	Cl	Coliform (MPN per 100 ml.)
Lorenzo	11/29	184	274	20	Less than 23
Roberts	8/1	168	224	8	
Roberts	11/29	178	254	16	620
King Hill	8/23	196	322	26	230
King Hill	10/20	196	341	28	
Nyssa	9/6/50	214	428	30	2,400
Nyssa	12/27	202	382	31	7,000
Weiser	9/7	164	311	21	240,000*
Weiser	9/20	162	300	22	240,000*
Weiser	8/24	154	318	20	240,000*

* Just off Weiser Shore.

Water Quality Data
(From U.S.G.S. Water Supply Papers 1189, 1163, 1264, and 1362)

Stream	Location	Date	Total Hardness (ppm as $CaCO_3$) Max.	Min.	Dissolved Solids ppm Max.	Min.	Sus. Sed. ppm Max.	Min.
Green R.	Green River, Utah	1949-50	479	178	857	251	10,000	46
"	?	1948-49	406	200	824	334	10,000	100

Stream	Location	Date	Calcium Eq./million Max.	Min.	Magnesium Eq./million Max.	Min.	Dissolved Sol. (ppm) Max.	Min.
Snake R.	King Hill, Idaho	3/51 to 9/51	2.59	2.15	1.73	1.32	336	283
"	"	10/51 to 9/51	2.59	2.00	1.81	1.23	359	252

PULPING PROCESSES - WASTE CONTROL MEASURES
WASTE LOADS, EFFECTS OF WASTES, AND WATER NEEDS

In considering water, waste loads, and effects of wastes, recognition must be given to the fact that there can be wide variation in these several factors. The variation may be due to type of pulping process, volume of production, and waste control measures practiced, including plant design and operation.

Pulping Processes

Types of pulping processes include kraft, sulfite (calcium, ammonium, or magnesium), semi-chemical (possibly in combination with other processes), groundwood, and others.

Waste loads produced by the calcium sulfite process, are usually large. Utilization of the recoverable liquors, although practiced to a limited extent, has not reached the stage of development and broad adoption as to give assurance of its applicability at the sites being considered. Recovery of chemicals is practiced at magnesium and ammonium sulfite plants. The Forest Service advises that approximately 40 per cent of the timber species available for pulping in the area is lodgepole pine. Normally, pine is not regarded as suitable for pulping by the conventional sulphite processes because the pulping liquor fails to free the fibers in the heartwood. The remaining timber resources, consisting of fir and spruce, could be used in the sulfite process. In view of the conditions discussed, no further consideration of the sulfite process is given in this report.

Mechanical or groundwood pulp is produced from fir and spruce, and

certain types of pine wood. Pine of high heartwood content heavily impregnated with resins has been found unsatisfactory. However, any of the southern pine substantially free of heartwood can be used for making groundwood pulp of suitable quality for newsprint. Information from the Forest Service indicates that pulping of lodgepole pine has been accomplished on an experimental basis. Also, with respect to whether the groundwood process would likely be considered there is the question of whether the industry would be developed in connection with lumber operations, in which case, the raw material might be delivered partially in the form of chips. Although there may be factors tending to preclude use of the groundwood process possibility of its use is sufficient to consider suitability of sites with respect to water requirements and waste loads of the process.

The kraft process can be used for all of the timber species available in the area. It is believed this process is the one most likely to have application. Consequently, principal attention is given to the kraft process in this report.

In addition to the pulping process itself, consideration should be given to processing of the pulp into end products. Predominantly, but not in all cases, paper making or some other product is associated with kraft pulp mills. The paper may be bleached or unbleached. Attention is given to these features in considering suitability of sites.

Volume of Production

The production rate is an obviously important factor. Water use and waste loads are considered to vary in direct proportion to the production rate.

Control Measures Practiced

It is possible in pulp and paper manufacture to make multiple use of water. Such practice will greatly reduce the water requirements and waste volume. For instance, a kraft pulp and paper mill might use water in heat exchangers such as the turpentine condensers, then, on the paper machine, next for diluting pulp in screening and refining operations, and finally for condenser water in the black liquor evaporators. Such practice may be adopted where the water supply is limited or where a reduction in waste volume aids treatment. Generally, reduction in water use also accomplishes a reduction in the quantity of pollutional constituents in the wastes.

In addition to such multiple use accomplishments, which principally reduce water quality used, there are important in-plant reduction measures in those processes embodying chemical recovery which reduce the amount of pollutional constituents. These measures retain a maximum amount of the process chemicals and organic waste materials in the liquor fed to the recovery process. Such measures would include operation of a closed countercurrent pulp washing system, adequate evaporator capacity and evaporator operation such that excessive carry over does not occur, and reuse of at least some of the condensate for pulp washing.

Control measures also include waste treatment facilities. Measures to recover fiber from pulp and paper mill waste are universally applicable throughout the industry. Some progress in developing and applying treatment methods for pulp and paper mill wastes have been made in recent years. Treatment of kraft mill wastes by sedimentation basins, oxidation lagoons, and activated sludge plants are being used at a few mills. Use of holding

ponds or lagoons of sufficient size to permit leveling out of peak or unexpected loads should be provided as a minimum control measure. Provision of lagoons with long-term holding capacity would permit discharge of wastes at selected times when stream flow is highest. In the particular area under consideration, water from lagoons might be used for certain irrigation purposes, thus avoiding the problem of stream pollution.

In this report the in-plant design and operation waste control measures plus minimum size holding ponds or lagoons will be used as the basis for arriving at basic waste load values. Other waste control measures are referred to as "special measures" and may be considered where stream flows are such that pulp mills would not otherwise be feasible.

Waste Loads

Waste loads from a kraft pulp mill can vary over a wide range depending on "basic" control measures in effect and the efficiency with which they are practiced.

It is not the purpose of this report to specify control measures which should be practiced. Rather, it is the purpose to indicate feasibility of pulp mill installations under certain attainable operating conditions. Accordingly, evaluations of site suitability have been made on the basis that improved design and operation is rigidly in effect. Should it be contemplated, for any reason, that there will be departure from the assumed bases of evaluation for any installation a re-evaluation of limitations on capacity should be made.

Volume of waste loads and biochemical oxygen demand are characteristics which can be expressed in terms of measurable units. In a modern

kraft plant the following values are obtainable:

Product	Waste Load Per Ton of Pulp: Waste Volume (Gallons)(1)	Waste Load Per Ton of Pulp: Pounds 5-day 20°C Biochemical Oxygen Demand
Kraft Pulp (unbleached)	16,000	20
Kraft Pulp & Paper (unbleached)	20,000	24
Kraft Pulp (bleached)	45,000 - 75,000	45
Kraft Pulp & Paper (bleached)	50,000 - 80,000	50

(1) Does not include condenser water from power plants. This may amount to 10,000 to 28,000 gallons per ton of pulp.

The values given are for well operated plants. There are many instances where these values are exceeded. Values as high as 60 pounds of 5-day 20°C. biochemical oxygen demand per ton of unbleached kraft pulp, accompanied by a waste flow of as much as 40,000 gallons, represents an upper limit which should not be exceeded except in a very poorly operated plant.

Toxicity is another kraft waste characteristic which is important with respect to dilution requirements. There have been numerous investigations of kraft waste toxicity. Many of these have been concerned with measurement of the concentration of certain constituents which were considered to be the principal causes of toxicity and determination of the toxic limits of each of these constituents. Other studies have been made of the toxicity of the "whole" waste. Some studies have been limited to determination of lethal limits to fish over a limited period of time.

Others consider effects to environment which may have a long term damaging effect. Views on desirable dilution for kraft wastes cover a wide range. Conclusions based on some investigations state that toxicity of waste to fish and other aquatic life is of small significance provided sufficient dilution is available to take care of oxygen demand. Other investigations indicate that dilution ratios for "whole" kraft waste of 50 to 1 or greater can cause damage to aquatic life.

Differences in views on dilution requirements may be due to differences in basic plant control measures, operation practices, use of selected constituents as indices of toxicity as compared to use of the whole waste, or other factors. It is believed that rigid applications of available control measures can substantially reduce dilution requirements indicated by investigations made at some existing plants.

In order to serve as a guide in determining mill size limitations at selected sites it is necessary to accept some level of toxicity control and estimate a corresponding dilution requirement. For the purposes of this report it is considered that, with reasonable control of toxic wastes, flows of 400 to 500 cubic feet per second per 100 ton pulp capacity will provide protection against toxicity. If, in possible development by industry, controls are provided which will assure a lower level of toxicity than indicated by the above estimate corresponding changes can be made in mill size limitations indicated in the report.

Characteristics of kraft wastes with respect to color and tendency to promote aquatic growths are discussed under the subsequent section on effects of wastes.

Fiber losses from pulping processes may be of great significance in the effects of waste on aquatic life, particularly if quiescent stream areas exist below the point of waste discharge, unless proper measures are taken to remove the fibers before discharge to the stream. Fiber losses can be controlled to a satisfactory degree by recovery measures and settling in sedimentation basins or lagoons.

Wastes from groundwood pulp plants are of much less significance than from kraft plants. Available information on water use indicates a range of 5,000 to 16,000 gallons per ton of pulp. The biochemical oxygen demand (5-day, 20°C.) should not exceed 3 to 5 pounds. Care should be taken to avoid discharge of suspended fibers, waste bark, rejects, and other debris to the streams. Bleaching of groundwood pulp might be by the peroxide or zinc hydrosulphite processes. Information on wastes from these processes is not readily available. Since these processes do not reduce pulp yield significantly the wastes would not be expected to have appreciable oxygen demand. Wastes from the peroxide process would not be expected to have a significant degree of toxicity. Wastes from the zinc hydrosulphite process could be significant due to residual amounts of zinc.

Effects of Wastes

The oxygen demand of pulp wastes tend to reduce the oxygen content of receiving streams. If the demand is too great residual oxygen in the streams may be so low as to destroy fish directly or be inimical to their propagation. Complete depletion of oxygen will result in septic conditions in the receiving streams.

Toxic effects have been discussed in the preceding part of this section of the report.

Kraft mill wastes cause color, foaming, and tastes and odors in receiving streams. At dilution ratios considered desirable for other purposes (i.e. protection against toxicity) these characteristics would be noticeable in stream sections immediately below pulp mill locations but would not be too significant with respect to expected water uses, including irrigation or aesthetic values. At lower dilution ratios consideration should be given to proximity of water uses.

Typically, pulp wastes cause Sphaerotilus growths in streams below waste outlets. The limiting concentrations of waste constituents favorable to these growths are not definitely known. However, the growths do occur even when oxygen demand of wastes is quite low. Under conditions of waste discharge considered acceptable with respect to other effects Sphaerotilus growths can be expected in limited stream sections. Aside from possible aesthetic values and limitation on use of the stream sections for swimming damage from these growths would not be considered serious for the sites under consideration.

A very small per cent of fiber loss can result in extensive accumulation of fiber on the bottom of the receiving stream and cause damage to fish and other aquatic life.

ANALYSIS OF SITE SUITABILITY

Factors Affecting Site Suitability

The general factors influencing selection of mill sites for study have been listed in the introduction. Factors considered in this report are limited to those concerned with water supply and waste disposal.

Basic information on water supply, water quality, existing waste loads, stream temperature and physical characteristics, existing water uses, pulp industry water needs and waste loads, and waste control measures, have been presented in appropriate sections of the report. All of these factors are involved in analysis of site suitability.

Water quality objectives are of basic interest in determining acceptable waste loads to streams. These have been discussed with State Health Department representatives. In general the objectives will be to maintain water in condition suitable at all times without treatment for irrigation, stock watering, fish (of the species found in the area) and other aquatic life propagation, other wild life uses, recreation (except swimming) and as a source for industrial water supplies. No domestic water supplies are involved within distances which would be influenced by proposed sites. In order to meet these objectives analyses have been based on maintaining a minimum average daily dissolved oxygen of not less than 5 parts per million. The dilution water required to provide protection against toxicity to fish life, including fish food organisms, is a matter on which variable views exist. It is considered that, with a dilution of 400 to 500 cubic feet per 100 tons of pulp production per day, protection against toxicity is

readily attainable. There are reports which indicate control measures available can reduce the toxicity factor so that much less dilution is required. This analysis uses the high dilution value for evaluating the upper limits of flow requirements (or, conversely lower limit of pulp mill size) for toxicity protection. Where control measures are contemplated which will assure protection against toxicity there can be a corresponding change in the limiting plant size. The dilution requirements for fish and aquatic life will also provide protection for other water uses, including stock watering and irrigation.

In evaluating oxygen depletion - waste load relationships deoxygenation and reaeration coefficients used were those found by experience elsewhere to be reasonable for the types of streams and other physical conditions observed or predicted.

Boise-Payette-Weiser Area

Expected low flow conditions in the lower Boise and Payette Rivers, along with present pollution loads, tributary to the Boise River, preclude consideration of these areas as a desirable pulp mill site.

The most desirable location along the Snake River in this area, from the standpoint of existing water uses, would be below Weiser. This would prevent possible damages to the Weiser water supply and would keep the plant some 40 miles below an existing major pollution source tributary to the Snake River and 60 miles below one discharging to a tributary of the Boise River.

The reported existing waste loads as tabulated elsewhere have been

used, in conjunction with waste loads which could be expected from a pulp plant, to analyze deoxygenating effects of the pulp mill wastes on the river at Weiser. In using the existing waste loads recognition is given to the fact that two of the largest sources of waste are seasonal in operation and discharge wastes between late fall and early spring. The analysis indicates that dissolved oxygen levels will be maintained above 5 parts per million with discharge of wastes from a 500 ton kraft pulp mill, including provisions for bleaching and paper production, added to upstream existing waste loads. Dilution which would be obtained would be ample for protection against toxicity to fish and aquatic life. These conclusions have been reached without the necessity of a detailed analysis in view of the large flow available. If there are possibilities for a larger installation it appears that wastes from a pulp mill double the 500-ton size could be handled satisfactorily. In the event it is desirable to consider this possibility further a detailed analysis should be made, taking into consideration desirable reserve capacity for other potential industrial development.

Installation of a groundwood pulp mill would be feasible within any limits of size which might be anticipated in the area.

Bliss-Hammett Area

The two existing large pollution loads discharged to the Snake River and tributaries above the Bliss-Hammett area are about 96 and 75 miles above Bliss and 36 miles further from Hammett. These wastes are seasonal and would be discharged between late fall and early spring months.

The expected average monthly flow for minimum months for each quarter

of the year is given in Table 2. Special attention is called to the notes regarding Table 2 with reference to wide fluctuation from the average flow due to power operation. This analysis will assume that lagooning of wastes will be practiced and that waste discharge can be regulated in accordance with the stream flow.

The same conclusions with respect to installation of a 500 ton kraft pulp mill below Weiser apply at this location. Similarly, if it is found desirable to consider a larger mill, further detailed analysis should be made. There would be no limitation, within reason, on size of a groundwood pulp mill in this area.

Blackfoot-St. Anthony-Heise Area

As previously discussed, because of patterns of water use and flow conditions, the most favorable conditions for location of a pulp mill in this area are in the general vicinity of Roberts below the confluence of Henry's Fork and Snake River.

Analysis of site suitability is limited to this more specific area. Should study of other physical and economic conditions indicate reasons for further consideration the analysis can be extended.

The section of the report on existing waste loads includes an estimate of waste loads in the area. The major loads contributed are from the beet sugar and potato industries. These loads are seasonal in nature and will be added in the fall, winter, and spring months. In view of this situation the summer months will not be the critical period with respect to dissolved oxygen.

Information received on ice cover indicates that the critical dissolved oxygen situation will occur in the American Falls Reservoir during the winter. An analysis of waste load residuals entering the reservoir indicates that the remaining ultimate oxygen demand will be about 10 parts per million under critical winter flow conditions. Exertion of this demand during retention in the reservoir could reduce the available oxygen substantially an equivalent amount. Under these conditions additional waste load would be undesirable. A pulp mill located in the Roberts area would add waste load to the reservoir under winter temperature conditions. The additional load from a 250 or 500 ton pulp mill would be small in comparison to the existing loads. A relatively small reduction, percentagewise, in existing loads would remove restrictions on a pulp mill installation from an oxygen demand standpoint.

If provisions are made to reduce existing waste loads the toxicity factor would limit the desirable mill time to about 250 tons per day capacity. If adequate measures are taken to control the toxicity factor it appears that a 500 ton pulp and paper mill could be installed with reasonable control of existing waste loads. This conclusion assumes a well designed and operated mill with provision of lagoons to level out unexpected peak loads. If bleaching is included a lagoon adequate in size to provide prolonged storage should be a prerequisite to the installation.

Green River Area

Past flow records indicate that future minimum monthly average flows of about 250 cubic feet per second can be expected. Provision for long term storage of wastes or equivalent special waste treatment is considered a

requirement if a kraft pulp mill is to be installed in this area. Such storage would materially reduce the B.O.D. waste load and would permit discharge on the basis of long term average flows. Some reduction in the toxicity factor could also be expected. With a well designed and operated mill, including long term storage of wastes, it is considered that a 150 ton mill would be feasible. This conclusion is based on expected flow conditions with present water utilization. Should plans for upstream irrigation, or other water use, be such as to materially reduce flows or otherwise affect the capacity of the stream to receive wastes, reconsideration should be given to this conclusion. The preceding limitation on size is based primarily on dilution for protection against toxicity. With long term storage oxygen demand would not be a governing factor even if bleaching and paper making is included. If adequate measures are taken to reduce toxicity of waste it is feasible to operate a 200 ton mill.

Installation of a groundwood pulp plant of 500 to 1,000 ton capacity (without bleaching or production of end products) would present no critical problems of waste disposal. If bleaching or production of end products is contemplated limitations as to capacity would be governed by the processes employed.

In the preceding analyses of specific sites the matter of water quality suitable for pulp and paper production has not been considered. In all uses the available supply can be made suitable by treatment to the extent required. Whether or not the quality of water available will be a factor in selecting a site is dependent on an economic appraisal of any treatment thought desirable by industry with regard to the end product

manufactured. Feasibility of plant installation, as it may be governed by process water quality, is a matter for consideration by industry.

Although this report has not specifically been concerned with site limitations with respect to air pollution from the standpoint of odor, recognition should be given to this factor. Sites should be selected as remotely as possible from areas where odor nuisance would be a problem. Special odor control measures might be required to prevent nuisance conditions.

TABLE 1

MINIMUM DAILY FLOWS BY QUARTERS (in c.f.s.)
(From U.S.G.S. Records)

	Snake River near Heise				Snake River Near Shelley			
	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.
	Cubic Feet Per Second							
1930	2200*	2860	3780	1500	-	-	1250	-
1931	2100*	2620	2600	1940*	-	-	499	390
1932	1710	2450	4220	2160	1190	2810	1380	855
1933	2100*	2380	3470	2040	1400	3030	1540	702
1934	1920	2850	2340	1760	1080	670	688	350
1935	1580	1920	3150	2000*	972	2080	1320	-
1936	-	1800	4110	2280	-	2500	960	1140
1937	-	2120	3140	2100	-	2780	840	906
1938	1940	2100	5170	2270	1910	2610	1100	1250
1939	2120	4640	3380	2080	1870	3990	1530	1560
1940	1810	3010	2620	1910	-	3290	1300	1400
1941	1770	3050	3390	2250	1140	2750	1730	1760
1942	1790	2170	3210	2340	1400	2610	1460	1320
1943	1910	6310	4580	2480	1310	7870	2470	2520
1944	2150	2320	2820	2140	2550	3330	1560	1660
1945	1800	2080	4090	2100	1800	2490	2460	1800
1946	2100	6220	3530	2480	2150	7290	1350	2390
1947	2100*	3150	3600	2420	1600	3920	1620	3000
1948	2050	2250	3080	2150	2310	3400	1980	2200
1949	1950	2810	3270	2300	2000	3660	1650	2700
1950	1850	3230	4160	3270	1750	4000	3310	3850
1951	3120	6140	6060	2600	2810	7650	3570	2800
1952	2650	6190	4180		3050	7390	1680	

* Data for Quarter Incomplete

TABLE 1 (Con't.)

MINIMUM DAILY FLOWS BY QUARTERS (In c.f.s.)
(From U.S.G.S. Records)

Year	Henry's Fork at St. Anthony				Henry's Fork Near Rexburg			
	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.
	Cubic Feet Per Second							
1930	-	-	501	-	-	458	422	-
1931	-	448*	413	-	-	247	250	295*
1932	-	-	666	-	-	770	548	705*
1933	-	-	559	-	-	1250	371	503*
1934	-	456*	522	-	183	200	250	240*
1935	-	711	590	-	-	552	319	-
1936	-	566	515	-	-	685	422	600
1937	-	-	570	-	-	539	363	906
1938	-	676	676	-	-	1240	476	-
1939	-	-	554	-	-	-	380	1080
1940	-	-	897	-	1140	650	670	846
1941	-	-	650	-	1060	840	715	912
1942	-	-	693	-	765	1230	640	1050
1943	-	-	796	-	780	2370	892	1070
1944	-	-	667	-	1450	776	680	1110
1945	-	-	684	-	843	1320	786	1360
1946	-	-	659	-	1250	1200	630	1460
1947	-	-	617	-	1120	1280	650	1290
1948	-	-	617	-	924	1550	595	1150
1949	-	-	636	-	1000	1450	660	1220
1950	-	-	668	-	1050	1360	781	1650
1951	-	-	840	-	1350	1300	705	1540
1952	-	-	890		1820	2020	764	

* Data for Quarter Incomplete

TABLE 1 (Con't.)

MINIMUM DAILY FLOWS BY QUARTERS (In c.f.s.)
(From U.S.G.S. Records)

Year	Snake River Near Hagerman					Snake River at King Hill			
	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.		Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.
	Cubic Feet Per Second								
1930	4800	5000	5220	5900		6780	6550	6780	8230
1931	5000	4600*	5000	5850		7010	6320	6320	7250
1932	5580	5200	5320	6000*		7250	6550	6550	7730
1933	5450	5080	5320	6150		8230	6320	6550	7980
1934	4950	4700	4820	5200		6780	6320	6320	7010
1935	5020	4880	5100	5600		6550	6100	6320	7490
1936	5310	5220	5500	5950		7010	6550	6780	7730
1937	5710	4800	4680	5900		7490	6550	6550	7730
1938	5380	5000	5380	5860		7490	7490	7010	7880
1939	6080	4780	5020	5820		8130	6480	6870	8000
1940	4860	4740	5060	5820		7010	6370	6620	7780
1941	4740	4980	5140	6580	Below	6660	6500	7030	7980
1942	6160	6080	5900	6930	Lower Salmon Falls	7800	7540	7060	8380
1943	7350	6300	6340	7650		8970	7390	7540	9030
1944	6760	5710	5940	6930		8060	6570	7110	8430
1945	7310	5790	6170	7630		8820	6860	7130	9130
1946	8000	6320	6230	7690		10100	7300	7490	9130
1947	6300	5400	6070	7530		8000	6710	7250	9220
1948	6890	7090	5940	7210		8760	8280	7180	8900
1949	9450	5390	4880	6720		11100	6660	5790	8620
1950	7340	5120	5080	5500		8800	7200	5660	8350
1951	9110	6230	3970	9340		10400	7470	5270	10900
1952	9300	7390	6450			11200	9000	8040	

* Data for Quarter Incomplete

TABLE 1 (Con't.)

MINIMUM DAILY FLOWS BY QUARTERS (In c.f.s.)
(From U.S.G.S. Records)

Year	Snake River Near Murphy				Snake River at Weiser			
	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.
	Cubic Feet Per Second							
1930	6800	7090	7000	8320	11800	8480	7180	9860
1931	7470	6670	6590	7370	10700	6480	6310	8680
1932	8210	7470	6600	8020	10500	17400	-	9420
1933	8020	6900	6500	8120	10700	12300	7470	9970
1934	6900	6200	6000	7200	11400	6860	7020	8200
1935	6800	6400	6400	7610	9470	8920	7350	8740
1936	7330	6790	7060	7890	9470	8690	7980	9780
1937	7610	70[illegible]	6520	8460	9970*	9230	7300	9780
1938	7750	8170	7200	8110	10400	16700	8690	11100
1939	8460	7140	7090	8200	11500	8690	8160	9930
1940	7980	6680	6740	8260	10700	8060	7950	10800
1941	7200	6980	7010	8470	11500	12000	8090	11400
1942	8240	8210	7250	8680	11400	14800	8730	11600
1943	9490	8500	7810	9220	14600	21900	10300	13200
1944	9000	7650	7390	8800	11600	11000	8520	11000
1945	9300	9040	7500	9280	11600	14800	9210	12000
1946	11100	8130	7450	9310	16800	14600	9280	12600
1947	8240	7370	7510	9370	14000	14600	9210	12200
1948	9310	9160	7250	9130	12800	15200	9640	11900
1949	12300	8300	6640	9260	14500	10700	8800	11800
1950	9740	7340	6330	9070	12500	21000	9570	14500
1951	11100	8500	6330	11100	15700	17600	10900	14600
1952	9340	10000	8200		17600	21100	11000	

* Data for Quarter Incomplete

TABLE 1 (Con't.)

MINIMUM DAILY FLOWS BY QUARTERS (In c.f.s.)
(From U.S.G.S. Records)

Year	Boise River at Notus				Payette River Near Horse Shoe Bend			
	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.
	Cubic Feet Per Second							
1930	395	26	25	71	599	2280	705	550
1931	383	19	12	16	600	1020	687	450*
1932	417	184	26	39	550*	2960	677	469
1933	505	103	28	41	628	1460	756	556
1934	98	20	16	31	1080	1560	524	506
1935	359	33	24	29	623	1530	505	436
1936	395	40	23	44	545	986	820	492
1937	345	29	19	34	464*	1410	833	516
1938	387	572	34	322*	1040	2380	1240	800
1939	372	28	17	75	715	1790	671	545
1940	408	21	18	170	925	2100	848	601
1941	370	36	20	169	714	3070	1090	904
1942	436	137	20	113	1050	2600	1040	714
1943	500*	2290	88	273	900	6160	1500	664
1944	399	24	26	122	671	1240	848	455
1945	409	66	35	18	671	1700	1020	713
1946	32	1340	375	268	988	3970	1400	899
1947	374	54	24	132	1140	3240	1190	400
1948	399	118	29	244	502	1780	1650	400
1949	430	118	23	160	650	2240	2210	671
1950	458	862	20	428	790	2260	2760	1110
1951	536	728	80	406	720	2980	1780	881
1952	880	800	94		784	1990	2450	

* Data for Quarter Incomplete

TABLE 1 (Con't.)

MINIMUM DAILY FLOWS BY QUARTERS (In c.f.s.)
(From U.S.G.S. Records)

	Payette River near Emmett				Green River near Linwood, Utah				
Year	Jan.- March	Apr.- June	July- Sept.	Oct.- Dec.	Jan.- March	Apr.- June	July- Sept.	Oct.- Dec.	Yearly Mean
	Cubic Feet Per Second Daily Minimum								
1930	530	1870	404	417					
1931	494	700	385	282					
1932	512	1800	422	418					
1933	626	1350	1030	546					
1934	1080	1190	329	402					
1935	508	826	336	140					
1936	442	1050	833	416					
1937	523	1220	560	432					
1938	3	3010	1040	660					
1939	730	1380	308	389					
1940	1000	1290	710	780	270	437	312	320	737
1941	770	2830	720	740	340	1130	736	380	1733
1942	1140	3250	670	489	290	1890	516	310	1981
1943	770	6240	840	641	380	2500	770	250	2677
1944	670	1140	680	385	400	2120	490	410	2087
1945	716	1980	690	508	320	1020	1320	260	1801
1946	1160	3150	959	810	480	2030	780	410	1968
1947	1230	3310	860	606	380	1460	1200	380	3088
1948	602	2020	1440	341	450	1670	462	554	1993
1949	657	1620	1620	270	370	1260	562	330	1876
1950	635	1640	1820	1120	390	1630	1170	340	3396
1951	811	3590	1060	672	480	2340	1200	680	3125
1952	20	1850	1470		640	1300	764	430	2777

TABLE 1 (Con't.)

MINIMUM DAILY FLOWS BY QUARTERS (In c.f.s.)
(From U.S.G.S. Records)

Year	Green River Near Fontenelle, Wyo.				Yearly Mean
	Jan.-March	Apr.-June	July-Sept.	Oct.-Dec.	
	Cubic Feet Per Second				
1947	360	813	910	360	2143
1948	290	830	430	450	1412
1949	340	800	508	315	1459
1950	340	1050	931	310	2367
1951	530	1290	962	395	2424
1952	560	910	620	400	1757

Table 2

Estimated Future Minimum Stream Flow
Locations on Snake River and Tributaries, Idaho

(Information from Bureau of Reclamation, Boise, Idaho
Explanatory Notes Follow Tabulation)

Stream	Location of Gage Station	Average Discharge in c.f.s. for Minimum Month During Period			
		Oct.-Dec.	Jan.-Mar.	Apr.-June	July-Sept.
Henry's Fork	St. Anthony	200	200	200	600
	Rexburg	280	350	380	50
Snake River	Heise	1,800	1,820	2,340	4,450
	Shelley	1,280	1,600	1,175	2,100
	Hagerman	4,540	4,090	3,820	3,700
	King Hill	6,860	5,520	5,760	5,900
	Murphy	7,500	7,000	6,460	6,480
	Weiser	9,840	8,580	7,830	9,260
Boise River	Notus	30	20	10	20
Payette River	Horseshoe Bend	50	50	100	1,500
	Emmett	20	50	290	770

Explanatory Notes

Based upon recurrence of same hydrologic conditions as experienced during period 1928-1952, inclusive; and irrigation development at a level reasonably expected in foreseeable future with recent economic trends.

Henry's Fork at St. Anthony.--Minimum flows in the future will not be materially different from present conditions, as little additional development is in prospect on this stream. Winter flows are governed largely by the need for winter diversions below gage to Egin Bench area. Some fluctuation can be expected, due to powerplants upstream. During irrigation season release of storage to canals downstream results in higher flows. Lags in storage

releases could cause short-period absolute minimums less than indicated.

Henry's Fork Near Rexburg.--Future conditions should not be materially different from present development. Return flows from upstream irrigation are believed to be pretty well stabilized, and deliveries of exchange storage water to downstream Snake River rights should not be materially different in future years. Canal operations upstream can affect absolute minimums. An average operational waste of about 50 c.f.s. cannot be eliminated in driest periods.

Snake River Near Heise.--Future minimum flows at this station during summer months will be determined by storage releases during critical dry periods. During the winter months, release of water to meet power loads will be at relatively uniform rate. In general, the fluctuations in flow due to power peaking operations at the Alpine and Palisades plants will be smoothed out by the Burns Creek reregulating reservoir, from which water will be released at a relatively uniform rate. Changes in downstream demands can result in variation from monthly mean values.

If Alpine Reservoir should not be constructed, minimum monthly mean flows will be reduced to about 1,000 c.f.s. in the winter quarters.

Snake River Near Shelley.--Future minimum flows at this station probably will be governed by storage operations at Alpine, Palisades, and Burns Creek. During the winter months, the effectiveness of the Palisades water-savings agreements entered into by the canal organizations will be a factor in maintaining larger flows at the station. Winter canal diversions, if practiced, as in the past, will reduce the amount of the power releases which reach this gage. Changes in irrigation demands by canals both above and below the gage will cause variations from monthly means. Should Alpine Reservoir not be built, there will be reductions in monthly mean minimum flows at this station corresponding to the reductions at Heise.

Snake River Near Hagerman.--Minimum flows at this location in the future will be dependent upon depletions of ground-water supply under Snake River plain and of return flows from the Twin Falls area. Some variation from monthly mean values can be expected due to powerplant operations upstream.

Snake River at King Hill.--Future minimum flows at this station are taken from the report of the Columbia Basin Interagency Committee. The monthly mean values will be subject to wide fluctuation for absolute minimums, due to the operation of the Bliss powerplant a short distance upstream. The magnitude of such variation may be greater or less than reflected by records in recent years, depending upon over-all integration of power systems.

Snake River Near Murphy.--Future minimum flows derived by correlation with flows at King Hill corrected for future return flows from Mountain Home development. Considerable deviation from minimum monthly mean flows can be expected from the operation of C. J. Strike powerplant upstream.

Snake River at Weiser.--Future minimum flows at this location have been estimated from the depleted flows of the river at Oxbow as estimated by the Columbia Basin Inter-Agency Committee by correlation. The minimum mean monthly flows will be considerably greater than the absolute minimums due to the effect of upstream power operations, as well as that of irrigation diversions.

Boise River at Notus.--Due to amount of constructed upstream development, it is not likely that recorded absolute minimum flows will not be materially altered in the future. Possible reductions which might result from increased drainage pumping could well be offset by return flow from the development of additional irrigation area on Mountain Home Project. The operation of headgates and wasteways in the lower Boise Valley can (and probably has, in the past) result in considerable variation in the absolute minimum flows.

Payette River Near Horseshoe Bend.--With the Scriver Creek powerplants and Garden Valley Reservoir in operation, future minimum flows at this location will be dependent upon fishlife and irrigation and power requirements in the lower Payette Valley. During the irrigation season, reservoir operation might result in absolute values below the monthly average value; minimums in other periods will probably be fairly constant.

Payette River Near Emmett.--Future minimum flows at this station will be dependent upon inflow below Garden Valley and Smiths Ferry, the irrigation demands for lower valley lands and the required power releases at Black Canyon Dam. Changes in the last two items can result in some variation between absolute and mean monthly minimum values.

Table 3

Year	Low Mean Monthly Flow (June-Sept. Period)		Mean Annual Flow	
	Green River	Linwood	Green River	Linwood
1938-39	582	590	1,330	1,570
1937-38	1,260	1,720	1,750	2,120
1936-37	596	570	1,620	1,890
1935-36	835	948	2,100	2,360
1934-35	410	408	1,130	1,270
1933-34	258	268	530	550
1932-33	486	502	1,210	1,460
1931-32	677	830	1,590	1,890
1930-31	353	366	810	920